



First record of *Aedeomyia squamipennis* (Lynch Arribálzaga, 1878) (Diptera: Culicidae) in the state of Maranhão: epidemiological implications and distribution in Brazil

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Abstract: We record *Aedeomyia squamipennis* from the state of Maranhão, Brazil (municipalities of Bacurituba, Barra do Corda, Cajapió, Governador Nunes Freire, and Santo Amaro do Maranhão). We show that this species is well distributed in the state. The potential in the epidemiology of avian malaria and arboviruses is discussed briefly in connection with its discovery in Santo Amaro do Maranhão, due to the great number of bird species on Lake Santo Amaro. Finally, we present the known distribution of the species in Brazil.

Key words: avian malaria; biomes transition; epidemiology; mosquito; Neotropical Region; South America; vector

The family Culicidae is currently divided into two subfamilies: Anophelinae with 488 formally described species; and Culicinae with 3,067 (HARBACH & KITCHING 1998; HARBACH 2017). Among the 11 tribes of Culicinae, Aedeomyiini is the smallest, with only seven described species in a single genus, *Aedeomyia* Theobald, 1901. *Aedeomyia* has two subgenera: *Aedeomyia* s.s. with six species occurring in the tropics, and the monotypic *Lepiothauma* Enderlein, 1923, recorded in the Afrotropical region only (TYSON 1970; BRUNHES et al. 2011).

Aedeomyia is pantropical, with all species occurring in the southern hemisphere. Four species extend their distribution north of the Equator but do not reach the Tropic of Cancer (BELKIN 1962; TYSON 1970). This genus is represented in the New World only by *Aedeomyia* (*Aedeomyia*) *squamipennis* (LYNCH ARRIBÁLZAGA, 1878: 151), an exclu-

sively Neotropical species whose distribution extends from Argentina to Mexico (LANE 1953). Although BELKIN et al. (1970) suggested that *Ad. squamipennis* may represent a species complex, until now no close new taxa have been described in the Neotropics.

Larvae of *Ad. squamipennis* have so far only been found in water sources with aquatic vegetation (BELKIN 1962; GABALDON et al. 1981; CONSOLI & LOURENÇO DE OLIVEIRA 1994). The adults are considered by many to be nocturnal and ornithophilic (GABALDON et al. 1977a, 1977b, 1981; LOURENÇO-DE-OLIVEIRA & SILVA 1985; CONSOLI & LOURENÇO DE OLIVEIRA 1994; NAVES et al. 1998; FORATTINI 2002). Not surprisingly, this species has been found naturally infected with avian *Plasmodium* Marchiafava & Celli, 1885 (GABALDON et al. 1977b, 1985; GAGER et al. 2008) as well as Venezuelan Equine Encephalitis virus complex (MITCHELL et al. 1985), Gamboa group (DÉGALLIER et al. 1992) and Bunyawera group (TURELL et al. 2005) arboviruses. The first two arboviruses are suspected of spending some portion of the intrinsic incubation period in birds (MITCHELL et al. 1985; DÉGALLIER et al. 1992).

Aedeomyia squamipennis is well distributed in Brazil, yet prior to this study this species had not been found in Maranhão (XAVIER & MATTOS 1989a), despite being known to occur in the neighboring Pará and Piauí states (XAVIER & MATTOS 1975; XAVIER et al. 1979).

Maranhão is located in a privileged position with respect to geography, in the transition zone between the two largest Brazilian biomes, the Amazon and the Cerrado, thus forming several different physiognomies (REBÊLO

et al. 2007). The state contains the largest continuous band of Brazilian mangrove (REBELO-MOCHEL 2011) and a small portion of Caatinga biome, with a predominance of deciduous and seasonal sub-deciduous vegetation (VELOSO et al. 2002). It also contains an extensive floodplain area called 'Baixada Maranhense' formed by flooded terrain, mangroves and sandbanks (VELOSO 1964). The latter area is greatly affected by the rainy season, which causes the formation of large lakes that completely alter the local landscape, making it akin to the Brazilian Pantanal. North-eastern Maranhão contains a unique ecosystem called the 'Lençóis Maranhenses', consisting of Restinga vegetation, freshwater lagoons, and lush sandy dunes (MIRANDA et al. 2012).

According to the literature, prior to this study there were 78 species of mosquitoes recorded in Maranhão state (VASCONCELOS et al. 1989; XAVIER & MATTOS 1989a; MOTTA & LOURENÇO-DE-OLIVEIRA 1995; AHID & LOURENÇO-DE-OLIVEIRA 1999; REBÊLO et al. 2007). We present in this manuscript the first record of *Ad. squamipennis* in Maranhão, describing its range in the state and its distribution in Brazil, as did BLANTON & PEYTON (1957) for Panama and GABALDON et al. (1981) for Venezuela.

The specimens used in this article are from three different studies. The first is an extensive inventory of phlebotomines conducted under the auspices of the Ministry of Health in the 11 municipalities with the highest rate of leishmaniasis in state. This research lasted two years (May 2012 to April 2014), in which samples were taken monthly and simultaneously in all municipalities studied. The second was the capture of sand flies, carried out in the vicinity of the Lençóis Maranhenses National Park, in villages of Barreirinhas and Santo Amaro do Maranhão, as described by PEREIRA-FILHO et al. (2015). The third is an inventory of sandflies in neighboring municipalities of Bacurituba and Cajapió in June 2016, both in region of Baixada Maranhense. All collections used incandescent, HP type CDC light traps (PUGEDO et al. 2005) that were activated during 12 hours (18:00-06:00 h).

All specimens were taken to the Laboratório de Entomologia e Vetores at the Universidade Federal do Maranhão (LEV/UFMA), where insects were screened and identified. The capture methods used were not species-specific, thus in addition to sandflies other insect groups were eventually caught by these traps, including mosquitoes. Vouchers specimens were pinned and deposited in the Coleção de Culicidae da Fiocruz (Fiocruz-CCULI), Rio de Janeiro-RJ, Brasil (Table 1). No samples for DNA were taken from the vouchers.

Aedeomyia squamipennis distribution map was created using the Quantum GIS version 2.16.2 (Figure 1). Data of distribution were derived from extensive review of studies reporting *Ad. squamipennis* in Brazil (Appendix, Table A1). Geographic coordinates were found in literature and internet sources, in some cases this data were approximate, but some localities coordinates were not found. Datum used for geographic coordinates was South American Datum (SAD69).

Identification was carried out by first using the key to Culicidae genera proposed by CONSOLI & LOURENÇO DE OLIVEIRA (1994), then using the key proposed by TYSON (1970) to identify species within genus *Aedeomyia*, and BRUNHES et al. (2011) as a supplementary tool. Furthermore, Dr. Monique Motta of the Laboratório de Mosquitos Transmissores de Hematozoários - Instituto Oswaldo Cruz (LATHEMA-IOC/Fiocruz) confirmed identifications by visual inspection of adults in stereomicroscope.

Aedeomyia squamipennis is the only representative of tribe Aedeomyiini in New World (Figure 2). Differs from all other mosquitoes of this region by following combination of characters: apex of mid and hindfemora with large tufts of outstanding scales (Figure 3); broad scales on torus, clypeus and flagellomere I; all flagellomeres thick and short; and flagellomeres II–XIII nearly equal in length (Figure 4); wings covered with broad yellowish, white and dark scales (Figure 5).

Aedeomyia squamipennis was found in five municipalities of Maranhão (specific localities are noted in parenthesis): Bacurituba (Santa Maria: -2.774784° , -45.723723°), Barra do Corda (Novo Brejo: -5.759478° , -45.3236°), Cajapió (Posto de Seleção: -2.839606° , -44.7244°), Governador Nunes Freire (Portão: -2.070258° , -45.8823°) and Santo Amaro do Maranhão (Riachão: -2.827825° , -43.1273°). Barra do Corda is located in the central region of the state, with a predominance of Cerrado vegetation and mixed forest (equatorial evergreen open forest with Cocal) (IBGE 1984). Governador Nunes Freire lies in the northwestern part of the Amazonian, although with quite deforested areas. Bacurituba and Cajapió are situated in north of state, near to the Rio Mearim mouth, in Baixada Maranhense region. Santo Amaro do Maranhão is located on the northeastern coast near the Lençóis Maranhenses National Park, which contains Restinga vegetation on paleodunes, associated with Cerrado (IBGE 1984).

Data presented in this study indicate that *Ad. squamipennis* is well distributed in the state of Maranhão, occurring in the central, north, northeastern and northwestern portions. With the inclusion of Maranhão now this species

Table 1. Voucher specimens of *Aedeomyia squamipennis* collected in Maranhão state deposited in the Coleção de Culicidae da Fiocruz (Fiocruz-CCULI).

CCULI number	Municipality	Locality	Collection date
3675	Santo Amaro do Maranhão	Riachão	15.XII.2011
3676	Governador Nunes Freire	Portão	09.X.2013
3677	Barra do Corda	Novo Brejo	25.III.2013
4036	Bacurituba	Santa Maria	10.VI.2016
4037	Cajapió	Posto de Seleção	08.VI.2016

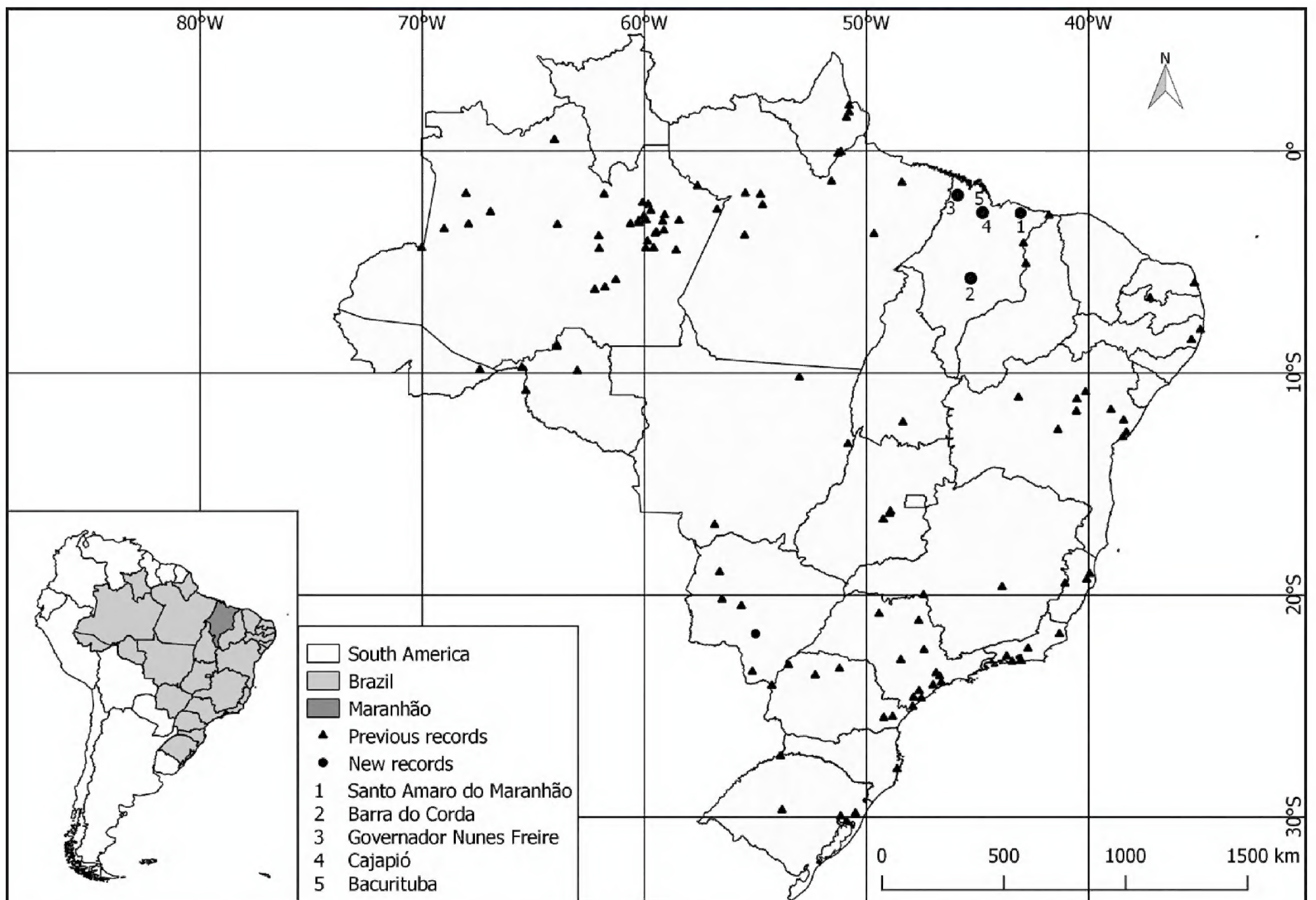


Figure 1. Geographic distribution of *Aedeomyia squamipennis* in Brazil based on literature records and collection data (black triangles), and new records from Maranhão state (black dots), based on present study.

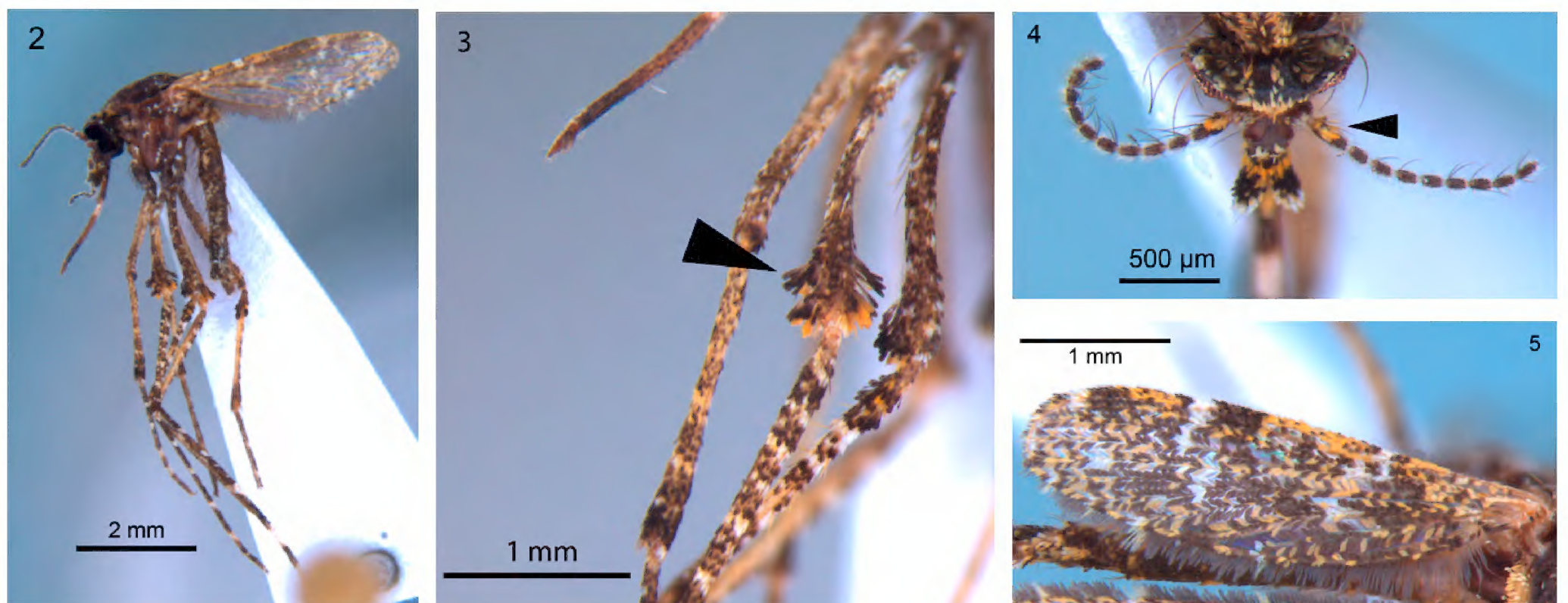


Figura 2–5. Some specimens of *Aedeomyia squamipennis* used in this study. 2. Female habitus of *Ad. squamipennis* (CCULI-4036). 3. Erect scales tufts at apex of the mid and hindfemur (CCULI-4036). 4. Scales covering the clypeus, torus and flagellomere I, all flagellomeres thick and short nearly equal in length (CCULI-4037). 5. Wing scales yellowish, white, and dark (CCULI-4037). Photos by Alexandre Xavier.

has been recorded in 21 federal states. The only states without records of this species are Roraima in the North region, Alagoas, Ceará, Paraíba and Sergipe in the Northeast, the Federal District in the Central-West.

Specimens of *Ad. squamipennis* were collected in trap installed in a henhouse in the Riachão location, Santo

Amaro do Maranhão municipality, providing evidence for the ornithophilic and nocturnal behavior (GABALDON et al. 1977a, 1977b; LOURENÇO-DE-OLIVEIRA & SILVA 1985; CONSOLI & LOURENÇO DE OLIVEIRA 1994; NAVES et al. 1998; FORATTINI 2002). Ornithophilic mosquitoes are often suspected during avian disease outbreaks. For

example, during an avian malaria epidemic in Venezuela, investigations to determine the ornithophilous species (GABALDON et al. 1977a) revealed *Ad. squamipennis* as a natural vector of avian malaria at that time (GABALDON et al. 1977b). GABALDON et al. (1985) suggested that this species is the likely vector *Fallisia (Plasmodioides) neotropicalis* Gabaldon, Ulloa & Zerpa, 1985 in Venezuela, and had previously been considered a vector of *Plasmodium* from subgenera *Giovannolaia* Corradetti, Garnham & Laird, 1963 and *Novyella* Corradetti, Garnham & Laird, 1963 (GABALDON et al. 1977b). *Aedeomyia squamipennis* was also found infected with *Plasmodium* strain PAN6 in Panama (GAGER et al. 2008). In a lengthy study that investigated infection of birds by haemosporidians in the Peruvian Amazon, SVENSSON-COELHO et al. (2013) found a *Plasmodium* strain similar to that observed for GAGER et al. (2008), and thus suspected *Ad. squamipennis* as the vector.

This species has also been implicated in arbovirus cycles, with prior investigators having isolated from adult mosquitoes Gamboa group virus, in which the natural cycle seems to involve birds (DÉGALLIER et al. 1992), as well as Venezuelan Equine Encephalitis (VEE) virus complex (MITCHELL et al. 1985). Although birds are not considered important hosts of VEE, DICKERMAN et al. (1976) showed that some Ciconiiformes can play a role in maintaining enzootic cycles. Such data demonstrate the capacity of *Ad. squamipennis* for contracting various parasites.

It is known that vector susceptibility to a parasite species can vary among populations, a phenomenon that may be explained by a combination of environmental conditions and ecological factors potentially altering vector-pathogen-host interactions (SANTIAGO-ALARCON et al. 2012), in addition to behavioral and ecological variation. Although *Ad. squamipennis* has never been found infected with avian *Plasmodium* in Brazil (SANTIAGO-ALARCON et al. 2012), this record in Santo Amaro do Maranhão indicates some epidemiological potential. The municipality lies on the Santo Amaro Lake, which borders the western edge of the Lençóis Maranhenses National Park. SOARES & RODRIGUES (2009) observed at least 41 species of birds occupying that lake, including resident and Nearctic migratory shorebirds (i.e., families Caradriidae and Scolopacidae). These two shorebird families are especially abundant in the dry season, which extends from September to November. Data from SOARES & RODRIGUES (2009) associated the presence of *Ad. squamipennis* in practically the same area as indicative of the potential vulnerability of the region to avian malaria and some arboviruses. The presence of migratory birds in the region may serve as a source of infection, and resident bird as point for dispersion of local parasite populations. Interestingly, of the 14 species of Ciconiiformes found by GABALDON et al. (1985) to be infected by *F. neotropicalis* in Venezuela, six were later reported on Lake Santo Amaro by SOARES & RODRIGUES (2009). There have been no ecological studies of mosquito fauna in Santo Amaro do Maranhão (and studies of mosquitoes are generally lacking in other municipalities as well), thus this is the first record

of Culicidae species in this municipality.

This new record of *Ad. squamipennis* raises the number of known mosquitoes species in Maranhão to 79. Based on its geographical position in transition zone and the wealth of ecosystems, lack of previous records of *Ad. squamipennis* may be explained by the lack of culicidofauna surveys. This finding indicates the need for entomological surveys in representative areas of the state, in order to better estimate the number of existing mosquito species. Studies that address ecological, behavioral and epidemiological facets of these organisms should also be carried out.

ACKNOWLEDGEMENTS

We thank to Maria da Conceição Bandeira (LEV/UFMA) and the technicians at FUNASA for help with field collections; Ciro dos Santos (LEV/UFMA) for contributions to and corrections of the various versions of the manuscript; Erick Chaves (LEV/UFMA) for screening the mosquitoes of Bacurituba and Cajapió; Alexandre Xavier (LATHEMA-IOC/Fiocruz) for photos; and Dr. Monique Motta (LATHEMA-IOC/Fiocruz) for confirmation of species. The staff of CCULI-Fiocruz for help in the deposit of voucher specimens. Two anonymous reviewers for suggestions in preview of the manuscript. FAPEMA for the technical assistance grant awarded to ACNP (Proc. no. BATI-02580/13). This study was financially supported by FAPEMA (Proc. no. APP-Universal-00216/12) and the Ministry of Health (with resources from Maranhão State and the Union).

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Authors’ contributions: ACNP collected part of the material, identified specimens, discussed the data, devised the study and wrote the manuscript. AAPF and JLPM collected material in different parts of the state and added geographic information. GAB made the map of distribution, and JMMR coordinated the projects used in this study, revised and added relevant information in the final draft.

Recevied: 12 September 2015

Accepted: 18 March 2017

Academic editor: Kirstern Lica Follmann Haseyama

APPENDIX

Table A1. Known records of *Aedeomyia squamipennis* in Brazil. Latitude and longitude are show only when georeferenced record could be found, albeit in some cases approximately. New records in the present study are highlighted in bold.

Region	State	Municipality	Locality: Sublocality	Latitude	Longitude	Reference
North	AC		Purus River Basin	−9.861008	−67.4109	NATAL et al. 1992
North	AP	Amapá		2.044851	−50.7875	SOUTO et al. 2011
North	AP	Mazagão		1.7452	−50.7894	SOUTO et al. 2011
North	AP	Pracuúba		−0.116673	−51.2864	SOUTO et al. 2011
North	AP	Santana	Villa Amazonia	−0.050674	−51.1551	FORATTINI et al. 1973
North	AP	Tartarugalzinho		1.506173	−50.9092	SOUTO et al. 2011
North	AM	Autazes		−3.725146	−59.5217	XAVIER & MATTOS 1976
North	AM	Autazes (as Itacoatiara)	Ambrosio Aires	−3.586098	−59.1261	XAVIER & MATTOS 1976
North	AM	Autazes (as Itacoatiara)	Capivara Lake (as Capivara)	−3.666507	−59.4665	XAVIER & MATTOS 1976
North	AM	Autazes (as Borba)	Canarama	−4.079492	−59.8668	XAVIER & MATTOS 1976
North	AM	Barcelos	Ararinha	0.496930	−64.0533	HUTCHINGS et al. 2016
North	AM	Benjamin Constant (as Fonte Boa)	Javarizinho	−4.375224	−70.0333	XAVIER & MATTOS 1976
North	AM	Beruri (as Manacapuru)	Pirarara	−4.409548	−62.0383	XAVIER & MATTOS 1976
North	AM	Borba		−4.391624	−59.5881	CERQUEIRA 1961
North	AM	Borba	Belém	−4.387882	−59.9484	XAVIER & MATTOS 1976
North	AM	Borba	Recreio	−4.376506	−59.5927	XAVIER & MATTOS 1976
North	AM	Coari	Caimbé	−3.317519	−63.9188	XAVIER & MATTOS 1976
North	AM	Coari	Maquapari			XAVIER & MATTOS 1976
North	AM	Codájas		−3.839865	−62.061	CERQUEIRA 1961
North	AM	Fonte Boa	Paraná da Alegria			XAVIER & MATTOS 1976
North	AM	Humaitá	Bom Futuro	−6.246951	−62.2394	XAVIER & MATTOS 1976
North	AM	Humaitá	Campo Novo			XAVIER & MATTOS 1976
North	AM	Irlanduba		−3.145614	−60.2574	FÉ et al. 2003
North	AM	Irlanduba (as Manaus)	Costa do Caldeirão	−3.246759	−60.2434	XAVIER & MATTOS 1976
North	AM	Itacoatiara		−3.135009	−58.4388	CERQUEIRA 1961
North	AM	Itacoatiara	Paraná da Eva	−3.180083	−59.1794	XAVIER & MATTOS 1976
North	AM	Itacoatiara (as Manaus)	AM-010 near km 175 (as Manaus-Itacoatiara Road)	−2.895101	−59.0928	DEANE et al. 1968
North	AM	Jupará	Ecological Station Juami-Jupará	−1.927087	−68.0381	HUTCHINGS et al. 2010
North	AM	Jutaí (as Fonte Boa)	Jutaí Mouth	−2.749514	−66.9337	XAVIER & MATTOS 1976
North	AM	Manacarupu		−3.289421	−60.632	CERQUEIRA 1961
North	AM	Manaus		−3.118908	−60.0216	LUTZ 1904
North	AM	Manaus	Porto Mauá	−3.113576	−59.9275	DEANE et al. 1968
North	AM	Manaus	São João Community: BR-174, km 4	−2.947889	−60.0287	BARBOSA et al. 2008
North	AM	Manaus	Biological Dynamics of Forest Fragments Project: Dimona Farm	−2.330691	−60.0824	HUTCHINGS et al. 2011

Continued

Table A1. Continued.

Region	State	Municipality	Locality: Sublocality	Latitude	Longitude	Reference
North	AM	Manicoré		−5.811544	−61.2915	CERQUEIRA 1961
North	AM	Manicoré	Boca do Marmelo	−6.144703	−61.781	XAVIER & MATTOS 1976
North	AM	Manicoré	Costa das Araras			XAVIER & MATTOS 1976
North	AM	Nhamundá	Nhamundá River: Igarapé da Areia: <i>Areia</i>	−1.587074	−57.6161	HUTCHINGS et al. 2013
North	AM	Nhamundá	Abacaxis River: <i>Paxiuba</i>	−4.480196	−58.5747	HUTCHINGS et al. 2013
North	AM	Novo Airão	Jaú National Park	−1.951161	−61.8165	HUTCHINGS et al. 2005
North	AM	Parintins		−2.639071	−56.7269	CERQUEIRA 1961
North	AM	Rio Preta da Eva (as Manaus)	Biological Dynamics of Forest Fragments Project: <i>Esteio Farm</i>	−2.418471	−59.832	HUTCHINGS et al. 2011
North	AM	Rio Preto da Eva	Vale Piratininga: <i>AM-010, km 78</i>	−2.70001	−59.7167	PEREIRA et al. 2009
North	AM	Santo Antônio do Içá (as Fonte Boa)	Vargem Grande do Içá	−3.3032	−67.9206	XAVIER & MATTOS 1976
North	AM	São Paulo de Olivença	Correnteza	−3.517008	−69.0185	XAVIER & MATTOS 1976
North	PA	Alenquer		−1.95972	−54.7761	XAVIER & MATTOS 1975
North	PA	Aveiro	Tapajós River: <i>Bôa Vista (Fordlândia)</i>	−3.812066	−55.49	TOWNSEND 1934
North	PA	Belém	Utinga State Park (as Utinga Captor de Agua)	−1.427829	−48.4083	HEINEMANN & BELKIN 1979
North	PA	Gurupá	Bacabal	−1.377542	−51.5821	XAVIER & MATTOS 1975
North	PA	Óbidos		−1.917154	−55.4589	XAVIER & MATTOS 1975
North	PA	Santarém		−2.440682	−54.6844	CERQUEIRA 1961
North	PA	Tucuruí	Tucuruí Dam	−3.743103	−49.6649	DÉGALLIER et al. 1992
North	RO	Ariquemes	Ariquemes Zoo	−9.908337	−63.023	FIOCRUZ-CCULI 2016
North	RO	Guajará-Mirim		−10.8034	−65.3383	XAVIER & MATTOS 1989b
North	RO	Porto Velho	Mato Grosso	−8.744507	−63.9444	GAMA et al. 2012
North	RO	Porto Velho	Abunã River	−9.763419	−65.5152	PEREIRA et al. 2009
North	RO	Porto Velho	São João	−8.819464	−63.9375	GAMA et al. 2012
North	TO	Peixe	Peixe–Angical Hydroelectric reservoir	−12.22365	−48.363	SILVA et al. 2010
Northeast	BA	Alagoinhas		−12.13721	−38.4253	GUEDES et al. 1978
Northeast	BA	Barra		−11.10302	−43.1643	LUTZ & MACHADO 1915
Northeast	BA	Camaçari		−12.68022	−38.3019	GUEDES et al. 1978
Northeast	BA	Jacobina		−11.18908	−40.5312	FORATTINI et al. 1970
Northeast	BA	Lençóis		−12.56337	−41.383	GUEDES et al. 1978
Northeast	BA	Piritiba		−11.72896	−40.5517	GUEDES et al. 1978
Northeast	BA	Ponto Novo (as Ponte Nova)		−10.86053	−40.1357	CHAGAS et al. 1937
Northeast	BA	Salvador (as Pirajá)	Pirajá	−12.8923	−38.4615	GUEDES et al. 1978
Northeast	BA	Serrinha		−11.66076	−38.9965	GUEDES et al. 1978
Northeast	MA	Bacurituba	Santa Maria	−2.774784	−44.723723	Present study
Northeast	MA	Barra do Corda	Novo Brejo	−5.759478	−45.3236	Present study
Northeast	MA	Cajapió	Posto de Seleção	−2.839606	−44.7244	Present study
Northeast	MA	Governador Nunes Freire	Portão	−2.070258	−45.8823	Present study
Northeast	MA	Santo Amaro do Maranhão	Riachão	−2.827825	−43.1273	Present study
Northeast	PE	Recife	Near Várzea	−8.051983	−34.9688	LUTZ & PENNA 1918
Northeast	PE	Ribeirão		−8.514625	−35.3737	COSTA 1956
Northeast	PI	Miguel Alves	Parnaíba River	−4.168151	−42.9397	XAVIER et al. 1979
Northeast	PI	Parnaíba		−2.910322	−41.7881	CHAGAS et al. 1937
Northeast	PI	Teresina		−5.085562	−42.8279	CHAGAS et al. 1937
Northeast	RN	Parnamirim (as Natal)	Cajupiranguinha	−5.955868	−35.2416	FORATTINI et al. 1970
Northeast	RN	Serra Negra do Norte	Seridó Ecological Station	−6.626615	−37.2443	FERNANDES 2011
Central-West	GO	Anápolis	Antas Stream (as Ribeirão das Antas)	−16.34092	−48.9663	MATTOS & XAVIER 1965
Central-West	GO	Anápolis	Olaria Farm (as Olaria)	−16.23419	−48.9279	MATTOS & XAVIER 1965
Central-West	GO	Goiânia	Naves Farm	−16.59484	−49.2467	NAVES et al. 1998
Central-West	MT	Cocalinho	Cristalino River	−13.20231	−50.8373	FORATTINI et al. 1970
Central-West	MT	Peixoto de Azevedo	Xingu Indigenous Park (as Xingu National Park): <i>Aldeia Pium</i>	−10.20429	−53.0263	LOURENÇO DE OLIVEIRA 1989
Central-West	MT	Poconé	MT-060 (Transpantaneira), km 52	−16.84287	−56.8399	ALENCAR et al. 2005
Central-West	MS	Anastácio	Morro Azul	−20.49151	−55.63753	FORATTINI et al. 1970
Central-West	MS	Aquidauana	Instituto de Pesquisas do Pantanal (IPPAN)			FIOCRUZ-CCULI 2016
Central-West	MS	Bataguassu	Santa Cruz Farm	−21.741977	−52.267504	GOMES et al. 2007
Central-West	MS	Corumbá	Embrapa Pantanal: <i>Nhumirim Ranch</i>	−18.970509	−56.61784	PAUVOLID-CORRÊA et al. 2010
Central-West	MS	Miranda	Noroeste do Brasil Railroad, km 136	−20.19805	−56.4997	LUTZ & NEIVA 1911

Continued

Table A1. Continued.

Region	State	Municipality	Locality: Sublocality	Latitude	Longitude	Reference
Central-West	MS	Miranda	Near Salobra station	−20.20163	−56.51014	TRAVASSOS & TEIXEIRA DE FREITAS 1943
Southeast	ES	Linhares	Vale do Rio Doce: <i>Juparanã Lagoon</i>	−19.30588	−40.08552	NATAL et al. 2007
Southeast	ES	Sooretama	Sooretama Biological Reserve	−19.04878	−39.95271	TRAVASSOS & TEIXEIRA DE FREITAS 1948
Southeast	MG	Aimorés	Aimorés Hydroelectric power plant	−19.48336	−41.0647	BARATA et al. 2012
Southeast	MG	Lagoa Santa		−19.63945	−43.9007	GUEDES et al. 1978
Southeast	MG	Sacramento (as Igarapava–SP)	Grande River	−20.00214	−47.43342	TUBAKI et al. 2004
Southeast	RJ	Cachoeiras de Macacu	Reserva Ecológica de Guapiaçu Private Reserve of Natural Heritage	−22.40926	−42.73591	SILVA et al. 2014
Southeast	RJ	Campos dos Goytacazes		−21.75373	−41.31307	GUEDES et al. 1978
Southeast	RJ	Niterói	Itacoatiara	−22.97253	−43.03674	LABARTHE et al. 1998
Southeast	RJ	Rio de Janeiro	Jacarepaguá: <i>Granjas Calábria</i>	−23.00054	−43.44827	LOURENÇO-DE-OLIVEIRA & SILVA 1985
Southeast	RJ	Seropédica	BR−465, between UFRRJ and Seropédica city	−22.75882	−43.6955	HEINEMANN & BELKIN 1979
Southeast	SP		Região de Sorocabana			LANE 1939
Southeast	SP	Botucatu	Porto Martins (as Former Porto Martins station)	−22.92458	−48.45681	FORATTINI et al. 1970
Southeast	SP	Angatuba		−23.45209	−55.14448	FORATTINI et al. 1973
Southeast	SP	Barueri		−23.52109	−23.52109	FORATTINI et al. 1973
Southeast	SP	Cananéia	Folha Larga Farm	−25.02801	−47.92256	FORATTINI et al. 1986
Southeast	SP	Cordeirópolis		−22.47701	−47.41431	BARGHINI et al. 2004
Southeast	SP	Iguape	ETEC Eng. Agr. Narciso Medeiros (as Escola Agrícola de Iguape)	−24.66257	−47.53388	FORATTINI et al. 1978
Southeast	SP	Iguape	Sitio Embu			FORATTINI et al. 1978
Southeast	SP	Juquiá		−24.32314	−47.63279	FORATTINI et al. 1970
Southeast	SP	Juquitiba	Pedro de Toledo State Reserve	−24.06115	−47.00581	DUTRA et al. 1996
Southeast	SP	Pariquera–Açu	Pariquera–Açu Experimental Farm	−24.61479	−47.88404	FORATTINI et al. 1981
Southeast	SP	Ribeirão Preto	Tamanduá River	−21.15969	−47.65299	DURET & BARRETO 1956
Southeast	SP	São José do Rio Preto	Instituto Penal Agrícola	−20.84772	−49.43716	DIBO et al. 2011
Southeast	SP	São Paulo	Santo Amaro	−23.66003	−46.71432	FORATTINI et al. 1970
Southeast	SP	São Paulo	Capivari–Monos Environmental Protection Area	−23.93831	−46.63535	RIBEIRO et al. 2012
South	PR	Curitiba	Iguaçu Regional Park	−25.5245	−49.22462	TISSOT & SILVA 2008
South	PR	Guaíra	Itaipu Reservoir	−24.07642	−54.2696	TEODORO et al. 1995
South	PR	Londrina	São Domingos Stream	−23.31769	−51.22327	LOPES & LOZOVEI 1995
South	PR	Morretes	Paraná Environmental Institute II/ IAPAR	−25.48204	−48.82715	TISSOT & SILVA 2008
South	PR	Querência do Norte	Sonho Real Farm	−23.15178	−53.51785	TEODORO et al. 1994
South	PR	Terra Boa	Palmital Farm	−23.61015	−52.31419	BARBOSA et al. 1993
South	RS	Derrubadas (as Tenente Portela)		−27.25876	−53.87938	RUAS-NETO et al. 1994
South	RS	Porto Alegre	Venâncio Aires Street	−29.96761	−51.1708	PINTO et al. 1940
South	RS	Santa Maria		−29.68439	−53.80684	MARCONDES et al. 2003
South	RS	Santo Antonio da Patrulha		−29.83155	−50.49946	CARDOSO et al. 2005
South	RS	Viamão	Capão da Porteira: <i>Boa Vista Farm</i>	−30.18806	−50.8983	DEANE et al. 1969
South	SC	Palhoça	Serra do Tabuleiro State Park: <i>Baixada do Maciambu</i>	−27.842483	−48.6221	FERREIRA-DE-FREITAS et al. 2017

Legend/States: AC (Acre), AM (Amazonas), AP (Amapá), BA (Bahia), ES (Espírito Santo), GO (Goiás), MA (Maranhão), MG (Minas Gerais), MS (Mato Grosso do Sul), MT (Mato Grosso), PA (Pará), PE (Pernambuco), PI (Piauí), PR (Paraná), RJ (Rio de Janeiro), RN (Rio Grande do Norte), RO (Rondônia), RS (Rio Grande do Sul), SC (Santa Catarina), SP (São Paulo), TO (Tocantins).